



Appl. No. : 09/785,944
: February 16, 2001

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A laser for generating ultra-short optical pulses, comprising:
a cavity which repeatedly passes light energy along a cavity axis;
a length of multi-mode optical fiber having a cladding and doped with a gain medium and positioned along said cavity axis;
a pump coupled to said cladding for exciting said gain medium;
a mode locking mechanism positioned on said cavity axis; and
an optical guide positioned on said cavity axis which confines the light amplified by said multi-mode optical fiber to preferentially the fundamental mode of said multi-mode optical fiber.
2. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said mode locking mechanism comprises a passive mode locking element.
3. (Original) A laser for generating ultra-short optical pulses as defined in Claim 2 wherein said passive mode locking element comprises a saturable absorber.
4. (Original) A laser for generating ultra-short optical pulses as defined in Claim 3 wherein said saturable absorber comprises InGaAsP.
5. (Original) A laser for generating ultra-short optical pulses as defined in Claim 3 additionally comprising a power limiter for protecting said saturable absorber.
6. (Original) A laser for generating ultra-short optical pulses as defined in Claim 5 wherein said power limiter comprises a two photon absorber.
7. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a single-mode mode-filter fiber on said cavity axis.
8. (Original) A laser for generating ultra-short optical pulses as defined in Claim 7 wherein said single-mode mode-filter fiber is fusion spliced onto one end of said multi-mode optical fiber.
9. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein said multi-mode fiber is tapered at said fusion splice.
10. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein said single-mode mode-filter fiber is tapered at said fusion splice.

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11. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein both said single-mode mode-filter fiber and said multi-mode fiber are tapered at said fusion splice.

12. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said pump is coupled to said multi-mode fiber along said cavity axis.

13. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said pump is coupled to the side of said multi-mode fiber.

14. (Original) A laser for generating ultra-short optical pulses as defined in Claim 13 additionally comprising an optical coupler for coupling said pump to said multi-mode fiber.

15. (Original) A laser for generating ultra-short optical pulses as defined in Claim 13 additionally comprising a v-groove on said multi-mode optical fiber for coupling said pump to said multi-mode fiber.

16. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising a polarization beam splitter for outputting said ultra-short optical pulses from said laser.

17. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity comprises a pair of reflectors at its opposite ends.

18. (Original) A laser for generating ultra-short optical pulses as defined in Claim 17 wherein one of said pair of reflectors is partially reflecting and provides the output for said cavity.

19. (Original) A laser for generating ultra-short optical pulses as defined in Claim 17 wherein said mode locking mechanism comprises a saturable absorber, and wherein one of said reflectors is formed on a surface of said saturable absorber.

20. (Original) A laser for generating ultra-short optical pulses as defined in Claim 19 wherein said mode locking mechanism additionally comprises a power limiter for protecting said saturable absorber, and wherein said saturable absorber is formed on a surface of said power limiter opposite said one of said reflectors.

21. (Original) A laser for generating ultra-short optical pulses as defined in Claim 20 wherein said power limiter comprises a two-photon absorber.

22. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising a linear phase drift compensator on said cavity axis.

23. (Original) A laser for generating ultra-short optical pulses as defined in Claim 22 wherein said linear phase drift compensator comprises a Faraday rotator.

24. (Original) A laser for generating ultra-short optical pulses as defined in Claim 23 wherein said linear phase drift compensator comprises a pair of Faraday rotators.

25. (Original) A laser for generating ultra-short optical pulses as defined in Claim 22 additionally comprising a linear polarization transformer on said cavity axis.

26. (Original) A laser for generating ultra-short optical pulses as defined in Claim 25 wherein said linear polarization transformer comprises a wave plate.

27. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said mode locking mechanism comprises an active mode locking element.

28. (Original) A laser for generating ultra-short optical pulses as defined in Claim 27 wherein said active mode locking element comprises an optical amplitude modulator.

29. (Original) A laser for generating ultra-short optical pulses as defined in Claim 27 wherein said active mode locking element comprises an optical frequency modulator.

30. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said ultra-short optical pulses preferentially in the fundamental mode of said multi-mode optical fiber have a pulse width below 500 psec.

31. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising an environmental stabilizer on said cavity axis to assure that said cavity remains environmentally stable.

32. (Original) A laser for generating ultra-short optical pulses as defined in Claim 31 wherein said environmental stabilizer comprises a Faraday rotator.

33. (Original) A laser for generating ultra-short optical pulses as defined in Claim 32 wherein said environmental stabilizer comprises a pair of Faraday rotators.

34. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises an optical fiber doped with an amplifying medium to provide gain guiding.

35. (Original) A laser for generating ultra-short optical pulses as defined in Claim 34 wherein said amplifying medium is concentrated centrally within a fraction of the core diameter of said optical fiber.

36. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a single-mode optical fiber on said cavity axis.

37. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a mode-filter on said cavity axis.

38. (Original) A laser for generating ultra-short optical pulses as defined in Claim 37 wherein said mode filter excites the fundamental mode of said multi-mode fiber.

39. (Original) A laser for generating ultra-short optical pulses as defined in Claim 38 wherein said mode filter excites the fundamental mode of said multi-mode fiber with an efficiency of at least 90%.

40. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity additionally comprises a positive dispersion element.

41. (Original) A laser for generating ultra-short optical pulses as defined in Claim 40 wherein said positive dispersion element comprises a length of single-mode positive dispersion fiber positioned along said cavity axis.

42. (Original) A laser for generating ultra-short optical pulses as defined in Claim 41 additionally comprising an output coupler for limiting the light energy at said single-mode positive dispersion fiber to less than 10% of the peak power in said cavity.

43. (Original) A laser for generating ultra-short optical pulses as defined in Claim 42 additionally comprising a frequency converter for compressing pulses generated by said cavity.

44. (Original) A laser for generating ultra-short optical pulses as defined in Claim 43 wherein said frequency converter comprises a frequency doubler.

45. (Original) A laser for generating ultra-short optical pulses as defined in Claim 44 wherein said frequency doubler comprises chirped periodically poled LiNbO₃.

46. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said multi-mode fiber includes a core, and wherein said gain medium in said multi-mode optical fiber is concentrated centrally within the core of said multi-mode fiber.

47. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said multi-mode optical fiber is polarization-maintaining.

48. (Original) A laser for generating ultra-short optical pulses as defined in Claim 47 wherein said polarization-maintaining multi-mode fiber has an elliptical core.

49. (Original) A laser for generating ultra-short optical pulses as defined in Claim 47 wherein said polarization maintaining multi-mode fiber comprises stress-producing regions.

50. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity additionally comprises a fiber grating written onto said multi-mode fiber, said grating primarily reflecting the fundamental mode of said multi-mode fiber.

51. (Canceled)

52. (Canceled)

53. (Canceled)

54. (Canceled)

55. (Currently Amended) A method of generating ultra-short optical pulses, comprising:
circulating light energy within a laser cavity;
amplifying said light energy within said laser cavity in a bent multi-mode fiber; and
confining said light energy within said laser cavity substantially to the fundamental mode of said multi-mode fiber.

56. (Original) A method of generating ultra-short optical pulses as defined in Claim 55 additionally comprising mode locking said light energy.

57. (Original) A method of generating ultra-short optical pulses as defined in Claim 55 wherein said confining comprises mode filtering said light energy.

58. (Original) A mode-locked laser for generating high power ultra-short optical pulses, comprising:

A multi-mode optical fiber doped with gain material for amplifying optical energy;

[means] a source for pumping said optical fiber; and

[means] a tapered length of multi-mode fiber for confining the optical energy amplified by said multi-mode optical fiber to substantially the fundamental mode of said multi-mode optical fiber.

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SUMMARY OF INTERVIEW

Exhibits and/or Demonstrations

None

Identification of Claims Discussed

All of the pending independent claims of this application, namely Claims 1, 55 and 58.

Identification of Prior Art Discussed

Fermann et al (5,627,848)

Wyatt et al (5,422,897)

Proposed Amendments

Prior to the interview, Applicant's counsel faxed proposed amendments of Claims 1, 55 and 58 to the Examiner. Those proposed amendments were identical to the amendments formally made herein.

Principal Arguments and Other Matters

In sum and substance, the arguments made during the interview were the same as those made in the Remarks below.

Results of Interview

The Examiner suggested that the claim amendments as proposed be submitted in a formal amendment.